UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A238 975

(2)

REPORT DOCUMENTA[TION PAGE]

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY NA	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for Public Release; Distribution Unlimited
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE NA	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) STANFORD UNIVERSITY	5. MONITORING ORGANIZATION REPORT NUMBER(S) AFOSR-TR- 90 0985
6a. NAME OF PERFORMING ORGANIZATION STANFORD UNIVERSITY 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION AFOSR/NM
6c. ADDRESS (City, State, and ZIP Code) Department of Electrical Engr. Durand 117 Stanford, CA 94305	7b. ADDRESS (City, State, and ZIP Code) Bldg. 410 Bolling AFB, DC 20332-6448
8a. NAME OF FUNDING / SPONSORING ORGANIZATION AFOSR 8b. OFFICE SYMBOL (If applicable) NM	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER AFOSR 88-0327A (Contract or Grant Number)
8c. ADDRESS (City, State, and ZIP Code) Bldg. 410 Bolling AFB, DC 20332-6448	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO.: 61102F PROJECT NO.: 2304 TASK NO.: A6 WORK UNIT ACCESSION NO.:

11. TITLE (Include Security Classification)

Fast Algorithms for Structured Matrices with Arbitrary Rank Profile

12. PERSONAL AUTHOR(S)

Debajyoti Pal

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Thesis	FROM 1989 TO 1990	1990, May	211

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

triangular factorization, computation of rank profile solution to linear equations, inversion

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

See Back

91-05958

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Jon A. Sjogren	22b. TELEPHONE (Include Area Code) 202/ 767-4939 22c. OFFICE SYMBOL AFOSR/NM

91 7 23 032

83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Abstract

Triangular factorization, solution to linear equations, inversion, computation of rank profile and inertia (in the Hermitian case) etc. of general $n \times n$ matrices require $O(n^3)$ operations. For certain structured matrices including Toeplitz and Hankel matrices the computational complexity is known to be $O(n^2)$ or better. These structured matrices often arise in a wide variety of areas including Signal processing, Systems theory and Communications. Fast (i.e. $O(n^2)$) algorithms for these structured matrices have been actively studied for over twenty five years. However almost all the authors have assumed that the underlying matrices are strongly regular i.e. every principal submatrix is nonsingular. Although some fast algorithms have recently been developed for certain problems involving some of these structured matrices which may have one or more zero minors, several other problems remain unresolved; also a unified approach towards these problems is lacking. In this dissertation, we obtain several new results through a unified approach to the problems mentioned earlier.

First we derive fast (i.e. $O(n^2)$) procedures for computing a "modified" triangular factorization which is a LDU factorization where L is lower triangular (resp. U is upper triangular) with unit diagonal entries and D is a block diagonal matrix with possibly varying block sizes. Only strongly nonsingular matrices will always have a purely diagonal nonsingular D matrix. For the matrices we study the diagonal blocks are also structured: in particular they are Hankel (resp. Quasi-Toeplitz) for Hankel (resp. Toeplitz) and Quasi-Hankel (resp. Quasi-Toeplitz) matrices.

A particular application of our result is a fast method of computing rank profile and inertia, leading to alternative proofs of certain results due to Iohvidov (1974) on rank profile and inertia of Hankel and Toeplitz matrices.

Next using the results on modified triangular factorization we extended the Schur complement based approach of Chun [Chu89] for inversion of strongly regular Toeplitz and Hankel matrices to Hermitian Toeplitz, Quasi-Toeplitz, Hankel, and Quasi-Hankel matrices with arbitrary rank profile.

We apply our procedures for computing inertia to derive $O(n^2)$ procedures for computing root distribution of an n-th order polynomial with respect to the unit circle and the imaginary axis. In particular it has been possible to derive the first general recursive procedure for determining the root-distribution of a polynomial with respect to the unit circle: the classical Schur-Cohn test for this problem fails in the presence of certain "singularities," which correspond to a Quasi-Toeplitz Bezoutian matrix being non-strongly-regular.